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The Insect-Visitors of Flowers.

BY JOHN H. LOVELL.

GAULTHERIA PROCUMBENS L. Checkerberry, Creeping Wintergreen.

The low habit of growth of this species amid grass and moss renders it impossible to observe directly in nature the behavior of its insect-visitors. In passing from plant to plant bees are compelled to creep upon the grass or ground. To remedy this difficulty I placed several plants in an inverted position with a specimen of *Bombus ternarius*, taken while at work on the flowers, in a glass-covered box. At first it was greatly disturbed by these unusual conditions, repeatedly seeking the flowers, which were now in full view, beneath the leaves; but at the end of a few hours its movements became more quiet, and it was possible to hold the plant in its normal position and observe the movements of the bee with a hand magnifier. The front pair of feet cling to the minute recurved teeth of the corolla, the middle pair grasp its sides, and the length of the flower is such that the hind pair rest upon the adherent sepals at the base. The fore part of the head is pressed up as far as possible into the narrowed mouth of the flower, and occasionally the corolla is slit nearly to the base. The proboscis is inserted outside of the ring of stamens, passing over the anthers, and could be readily seen through the translucent side of the corolla, at the base of which the honey is freely secreted. The tongue was extended horizontally in different directions for one or two millimeters. The jarring produced by the bee probably serves to dislodge the pollen, for when the anthers were touched with a needle it fell freely upon a glass plate.

When the flower opens the stigma stands at the same level as the anthers obstructing the central opening. It is not moist or in a receptive condition. *G. antipoda* of New Zealand, according to G. M. Thomson, is likewise distinctly proterandrous. In older flowers the stigma stands in the mouth of the corolla and is covered with a viscid fluid; at this stage no insect can obtain the honey without coming in contact with it. The filaments are

dilated so that access to the honey from the inner side is impossible. They, as well as the inner surface of the corolla, are also densely clothed with soft woolly slanting hairs, as a protection against small insects and the wet.

Each anther is tipped by four unequal elastic awns. The two outer processes are shorter and stand obliquely, obstructing the path between the anthers. The terminal awns also diverge, affording a triangular passage for the proboscis of the bee. The tubes are recurved and turn inward slightly, bringing the pores directly at the end, partially facing each other, whereas, in *Gaylussacia resinosa*, the pores face the style. As the proboscis of the insect passes over these openings it is necessarily brought in contact with the pollen. Exteriorly the anther tubes are covered with a soft, white, farinaceous powder much finer than the pollen grains, which probably serves to protect the sensitive tongue of the bee.

The aromatic scented flowers are white with reddish calyx and pedicels. Unsuccessful attempts of bees to puncture the corolla with the mandibles are indicated by double crescent-shaped marks.

Visitors: Hymenoptera—Apidae: (1) *Apis mellifica* L., ♀, not common; (2) *Bombus vagans* Sm., ♂, common; (3) *B. consimilis* Cr., ♀; (4) *B. terricola* Kirby, ♂; (5) *B. ternarius* Say, ♀. July 31–August 3.

CHELONE GLABRA L. Turtle-head.

The English name is due to the form and general reptilian appearance of the flower. The corolla is 25 mm. long, sessile, and firmly held by the imbricated sepals and concave bracts. The upper lip posteriorly is broad and inflated, affording ample room for the body of the bee, which enters entirely within the corolla. A bee, which found difficulty in retreating from getting astride the filaments, was observed to turn completely around. In front the sides of the upper lip are flattened and bend slightly inward to form a keel within which lies the style. The apex is notched with the extreme margins recurved to afford easier ingress.

Midway in the lower lip there is a reëntrant fold, or concavity, which greatly narrows the entrance and from its elasticity causes the corolla to resume its original shape after the visit of an insect.

The mouth is 14 mm. wide and 5 mm. high at the apex of the upper lip. At each angle there is a tuft of hairs and the margins curve downward to exclude rain. This entrance is none too large to admit species of *Bombus*, which I have seen leave flowers because of the difficulty of entering and fly to others with larger openings. In front of the mouth the three-lobed apex of the lower lip forms a narrow convex landing-place. The sides turn abruptly downward so that the upper portion is but 4 mm. broad with pubescent edges. The body of the bee rests upon this landing-place, while the legs grasp the hairy sides and the head is brought directly in front of the corolla mouth.

The four heart-shaped anthers, about 4 mm. long, lie well forward in the angle formed by the sides of the upper lip. Their inner faces are applied together to form a single pollen-receptacle. The contiguous edges are densely woolly to protect the pollen and to prevent the relative displacement of the anthers by connecting the first pair above and the first and second pairs at the sides. The point of attachment of the anther to the filament is thin and membranous, permitting it to rotate freely. The broad and flattened filaments arch outward and run downward and backward to the base of the corolla. The inferior pair rest in two grooves in the lower lip and hold the pollen-reservoir in place. When a bee enters the flower it spreads apart the arched filaments opening the receptacle and covering the thorax with fine, dry grains of pollen.

The style curves upward from the point of insertion to the keeled anterior portion of the upper lip. Behind it stands the rudiment of the fifth stamen. When the flower expands the capitate stigma is appressed to the corolla above the pollen-receptacle. It is exerted by the gradual growth of the style, until it stands in the mouth where an insect entering the flower must come in contact with it. In the absence of guests self-fertilization would probably not occur, for no pollen could be detected on the stigma of flowers kept in my room during the entire period of inflorescence.

The flowers are faintly sweet-scented, white with reddish lips, and honey is secreted on the upper side of a yellow fleshy ring, which is protected by the hairy filaments. Three or four flowers upon each spike usually bloom at the same time. In this locality

they are sparingly visited by insects, and have often been watched unsuccessfully. I have repeatedly observed *Philanthus solivagus* flying from flower to flower and examining the lips for honey, but never entering the corolla. *Prosopis ziziae* was taken while endeavoring to penetrate the pollen-receptacle, and diptera may often be seen resting on the flowers. The corolla is sometimes wholly or partially destroyed by some insect, enabling bees to steal the honey.

Visitors : Hymenoptera—Apidae : (1) *Bombus vagans* Sm., ♂ ; (2) *B. consimilis* Cr., ♀ ; (3) *B. dorsalis* Cr., ♂. August 16–24.

IMPATIENS BIFLORA Walt. Spotted Touch-me-not.

The structure of both the normal and cleistogamic flowers has been described. August 10th I examined a large number of flowers ; none of the spurs were perforated, and they were visited legitimately by *Bombus vagans*, which made from seven to twelve visits per minute. The thorax was plentifully covered with pollen. August 23d to 27th I found hundreds of the flowers perforated and both honey- and bumble-bees stealing the nectar. A honey-bee was watched during twenty five successive visits, and in every instance they were made to the spurs. The number of visits per minute was about ten. Both the honey-bee and *Bombus terricola* were observed in the act of perforating the nectary. The maxillae alone were employed and were moved slowly back and forward for the purpose of puncturing the tissue. The perforation is usually 3–4 mm. from the end of the spur, which is 10–11 mm. long. Sometimes there is but one, sometimes several openings, or there may be a slit 3 mm. long. Though the honey-bee was not seen to enter the calycine sac, it frequently sought the anthers, and as the front of the head was dusted with pollen, inter-crossing would be accomplished if it visited flowers with the stigma exposed. Small coleoptera and spiders occasionally seek refuge in the sac, and various diptera are attracted to the outside by the bright colors.

Visitors : Hymenoptera—(a) Apidae : (1) *Apis mellifica* L. ♀ ; (2) *Bombus vagans* Sm., ♂ ; (3) *B. terricola* Kirby, ♀ ; (b) Andrenidae : (4) *Augochlora aurata* Sm., ♀, entered sac but did not find the nectar. The first three species are common.

CORNUS CANADENSIS L. Bunch-berry.

Flowers small and closely capitate with a single central floret and four lateral clusters, consisting, respectively, in one instance, of 1, 10, 9, 14 and 12,—or 46 florets in all. Conspicuousness is gained by four parallel-veined involucral bracts. Parts of the flowers in fours, petals valvate, and one, or not rarely two, awned. As the flower-bud approaches maturity the filaments grow rapidly, breaking apart the petals at the base and protruding as four V-shaped arches. If at this stage the awl-shaped appendage is touched by the body of an insect, or by a needle, the petals are instantly reflexed, the elastic filaments straighten, and a minute shower of pollen is projected upward. In fully matured flowers a faint snap may be heard. Self-fertilization is prevented by the immaturity of the stigma. The stamens surpass the pistil and in the bud the anthers rest against the style. Both stamens and petals soon fall away and the capitate stigma, composed of white papillae, subsequently matures. Though self-fertilization is prevented by proterandry there may occasionally be observed resting against the stigma the anthers of neighboring flowers. The honey is secreted in a very thin layer by a dark brown ring at the base of the style. There is a profusion of flowers, which remain in bloom a long time.

While the honey-bee and Andrenidae are common visitors there has never been seen upon the flowers a single species of *Bombus*. The absence of these insects is probably due to the small store of honey. Several small butterflies are occasionally attracted, but coleoptera are very rarely taken. A large company of diptera are important agents in inter-crossing. The flowers are frequented by a white spider, *Misumena vatia*, which preys upon the insects guests; in one instance it had captured a honey-bee, in another a crane-fly.

Visitors : A. Hymenoptera—(a) Apidae : (1) *Apis mellifica* L., ♀, common ; (2) *Nomada maculata* Cr. ; (b) Andrenidae : (3) *Andrena vicina* Sm., ♀, common ; (4) *A. commoda* Sm., ♀ ; (5) *A. claytoniae* Rob., ♀, common ; (6) *A. designata* Ashm., ♀ ; (7) *Halictus stultus* Cr., ♂ ; (8) *H. Cressonii* Rob., ♀ ; (9) *Sphecodes* sp. ; (c) Ichneumonidae : (10) *Ichneumon centrator* Say., ♂, rare, B. Lepidoptera—Rhopalocera : (11) *Lycaena pseudargiolus* Bois. & Lec. ; (12) *Chrysophanus americanus* D'Urban ; (13) *Thecla niphon*

Hub. C. Diptera—(a) Syrphidae: (14) *Sphaerophoria cylindrica* Say; (15) *Sericomyia militaris* Walk.; (16) *S. chrysotoxoides* Macq.; (17) *Pipiza pistioides* Will.; (18) *Criorhina intersistenas* Walk.; (19) *Chilosia tristis* Loew; (20) *Brachypalpus marginatus* Hunter; (21) *Criorhina nigra* Will.; (22) *Xanthogramma aequalis* Lw.; (b) Muscidae: (23) *Morellia micans* Macq.; (24) *Lucilia cornicina* Fab.; (25) *Pyrellia cadaverina* L.; (26) *Mydaea alone* Walk.; (c) Sarcophagidae: (27) *Helicobia heliciis* Town.; (28) *Sarcophaga* sp.; (d) Empididae: (29) *Rhamphormyia minytus* Walk.; (e) Anthomyiidae: (30) *Phorbia fuscipes* Zett.; (31) *Phorbia* sp.; (f) Asilidae: (32) *Cyrtopogon chrysopogon* Loew, one specimen; (g) Stratiomyidae: (33) *Odontomyia interrupta* Oliv., one specimen. D. Coleoptera—(a) Elateridae: (34) *Cardiophorus* sp.; (b) Lampyridae: (35) *Ellychnia corrusca* L.; (36) *Telephorus fraxini* Say. July 11—July 1.

CORNUS STOLONIFERA Michx. Red-osier Cornel.

Flowers white, in flat cymes, sweet-scented, honey abundant, secreted by a brown fleshy ring at the base of the style. Stigma covered with a viscid secretion and in a receptive condition when the flower expands, the anthers dehisce within an hour. The stamens stand nearly erect, are rather longer than the pistil and have their pollen-covered sides turned away from the stigma. The flower is 1 cm. broad so that fertilization of the stigma by the anthers of neighboring flowers does not occur. The flower of *Cornus Canadensis* L. is only 3 mm. wide.

The abundance of the honey attracts frequent visits of bumblebees, but the number of diptera is much less than in *C. Canadensis* L. Two species of millers were collected upon the sweet-scented flowers in the evening.

Visitors: A. Hymenoptera—(a) Apidae: (1) *Apis mellifica* L., ♀; (2) *Bombus ternarius* Say, ♂; (3) *B. terricola* Kirby, ♀; (4) *B. borealis* Kirby, ♀; (b) Andrenidae: (5) *Andrena salicis* Rob., ♀; (6) *Prosopis sparsa* Cr., ♀; (7) *Sphecodes dechroa* Sm., ♂; (c) Eumenidae: (8) *Ancistroceras capra* Sauss., ♂; (d) Ichneumonidae: (9) *Ichneumon Wilsonii* Cr., ♂; B. Diptera—(a) Syrphidae: (10) *Syrphus rufesii* L.; (11) *Tropidia quadrata* Say; (b) Muscidae: (12) *Pollenia rudis* Fab.; (13) *Lucilia caesar* L.; (14)

L. cornicina Fab.: (15) *Morellia micans* Macq.; (c) Anthomyidae: (16) *Phorbia fuscipes* Zett.; C. Coleoptera—(a) Elateridae: (17) *Corymbites metallicus* Payk.; (b) Lampyridae: (18) *Pyropyga decipiens* Harr. July 19–July 24.

CORNUS ALTERNIFOLIA L. Alternate-leaved Cornel.

As the flower expands the anthers and stigma mature simultaneously. The style is 3 mm. long and the stamens 6 mm. so that cross-fertilization would be favored by different parts of the bodies of insects coming in contact with the anthers and stigma. The open white cymes are very numerous and conspicuous, honey is secreted by a green, fleshy ring at the base of the style, odor faint, pleasant. In comparing the three preceding species of *Cornus*, it is noteworthy that in *C. Canadensis* L., where conspicuousness is gained by means of an involucre, the flowers are smaller, more closely set, there is effective provision against self-fertilization and a less abundant supply of honey; an arrangement that permits the honey-bee to visit the flowers so rapidly that the rate per minute could not be determined satisfactorily.

Hymenoptera are the most important agents in inter-crossing *C. alternifolia* L.; diptera are common but play a subordinate part compared with the bees; coleoptera are not common.

Visitors: A. Hymenoptera—(a) Apidae: (1) *Apis mellifica* L., ♀, common, sucking; (2) *Bombus terricola* Kirby, ♀, rare; (b) Andrenidae: (3) *Andrena commoda* Sm., ♀, common, collecting pollen; (4) *A. designata* Ashm. ♀; (5) *Andrena* (?) *viola* Rob., ♀ common; (6) *Halictus similis* Sm., ♀; (7) *Halictus* sp.; (8) *Sphecodes dechroa* Sm., ♂, rare; (9) *Agopostemon radiatus* Say, ♀, rare; (c) Eumenidae: (10) *Ancistroceras capra* Sauss., ♂. B. Diptera—(a) Syrphidae: (11) *Syrpitta pipiens* L.; (12) *Syrphus rufesii* L.; (13) *Pipiza pistioides* Will.; (14) *Chilosia* sp.; (15) *Helophilus latifrons* Loew; (16) *Temnostoma alternans* Lw.; (b) Muscidae: (17) *Pollenia rudis* Fab.; (c) Sarcophagidae: (18) *Helicobia helici* Town.; (d) Chironomidae: (19) *Ceratopogon* sp. C. Coleoptera—(a) Carabidae: (20) *Lebia viridis* Say; (b) Cerambycidae: (21) *Leptura lineola* Say; (c) Cephaloidae: (22) *Cephaloon lepturides* Newn.; (d) Cistellidae: (23) *Isomera quadristriata* Coup.; (e) Anthicidae: (24) *Corphyra lugubris* Say; (f) Chrysomelidae: (25) *Chrysomela scalaris*

Lec.; (26) *Orsodachna atra* Ahr.; (g) Curculionidae : (27) *Anthonomus cornutus* Lec.; (28) *Conotrachelus nenuphar* Hbst. June 19–July 1.

ARALIA RACEMOSA L. American Spikenard.

The size of this species is very variable and in rich, open woodlands may exceed six feet. In three umbels the number of flowers respectively was 39, 44, and 49. Proterandrous dichogamy is strongly developed as in the Umbelliferae. When the flowers open the styles are united and only a millimeter in length, while the stamens are three millimeters long, and stand erect with the anthers horizontal or inclining outward. The smaller diptera thrust their heads between the stamens, but the bodies of the larger pass over them. The first period of the inflorescence closes with the falling away of the stamens and petals.

Subsequently the styles elongate until about 3 mm. long, separate, and finally are reflexed. The stigmas are terminal and oblique, prolonged along the inner side of the style. For so small a flower the honey is abundant, and may be seen in minute drops on the epigynous disk. During the intermediate stage its secretion nearly ceases. The association of the flowers in a community permits insects to visit them rapidly; the honey-bee will make some forty visits in a minute, and *Lucilia cornicina* in the same time will examine twenty-six flowers.

The flowers are frequented by a large number of the less specialized hymenoptera, such as the ichneumon-flies and wasps. Bees with the exception of the honey-bee are not common. Of butterflies, *Argynnis aphrodite* is a very frequent visitor, other species are rarer. The diptera form a large and varied company.

Visitors : A. Hymenoptera—(a) Apidae : (1) *Apis mellifica* L., ♀; (2) *Bombus ternarius* Say, ♂; (3) *B. terricola* Kirby, ♀; (4) *B. vagans* Sm., ♂; (b) Andrenidae : (5) *Andrena commoda* Sm., ♀; (6) *A. rugosa* Rob., ♀; (7) *Halictus fuscipennis* Sm., ♀; (8) *H. Cressonii* Rob., ♀; (9) *Prosopis* sp.; (10) *Augochlora aurata* Sm., ♀; (11) *Sphecodes dechroa* Sm., ♂; (c) Vespidae : (12) *Vespa diabolica* Sauss., ♀; (13) *V. consobrina* Sauss., ♀; (14) *V.* sp., ♀; (15) *V. maculata* Fab., ♀; (d) Eumenidae : (16) *Eumenes fraternus* Say, ♂; (e) Crabronidae : (17) *Crabro nigrifrons* Cr., ♂; (18) *C.*

bigeminus Pat., ♀; (19) *C. sterpicola* Pach., ♀; (f) Nyssonidae: (20) *Gorytes* sp. nov.; (g) Sphecidae: (21) *Ammophila vulgaris* Cr., ♀; (h) Pompilidae: (22) *Pompilus scelestus* Cr., ♀; (23) *P.* sp. nov.; (i) Formicidae: (24) *Formica fusca* L., ♂; (j) Chrysididae: (25) *Perilampus triangularis* Brulle; (26) *Chrysis perpulchra* Cr.; (k) Ichneumonidae: (27) *Ichneumon Wilsonii* Cr., ♂; (28) *I. versabilis* Cr., ♂; (29) *I. malacus* Say, ♂; (30) *Linoceras cloutieri* Prov., ♂; (31) *Amblyteles subrufus* Cr., ♀; (32) *Gasteruption incertum* Cr. ♀; (33) *G. tassatorium* Say, ♀; (l) Tenthredinidae: (34) *Hylotoma clavicornis* Fab. B. Lepidoptera—(a) Rhopalocera: (35) *Argynnis aphrodite* Fab.; (36) *A. cybele* Fab.; (37) *A. bellona* Fab.; (38) *Limnitis arthemis* Drury; (39) *Melitaea tharos* Drury; (40) *Pamphila Peckius* Kby.; (41) *Chrysophanus americanus* D'Urb. (42) *Lycaena pseudargiolus* Boisd. & Lec.; (b) Zygaenidae: (43) *Ctenucha virginica* Charp. C. Diptera—(a) Syrphidae: (44) *Syrphus rufesii* L.; (45) *S. lesueri* Macq.; (46) *Sphaerophoria cylindrica* Say; (47) *Xylota analis* Say; (48) *Paragus angustifrons* Loew; (b) Muscidae: (49) *Morellia micans* Macq.; (50) *Lucilia caesar* L.; (51) *L. cornicina* Fab.; (52) *Pollenia rudis* Fab.; (53) *Mydaca alone* Walk.; (c) Sarcophagidae: (54) *Helicobia heliciis* Town.; (d) Tabanidae: (55) *Chrysops celer* O. S.; (56) *C. mitis* O. S.; (57) *Theriopteles epistatus* O. S.; (58) *Cistogaster immaculata* Macq.; (e) Tachinidae: (59) *Archytas analis* Fab.; (60) *Echinomyia algens* Wied.; (61) *E. decisa* Walk.; (f) Empididae: (62) *Rhamphomyia luteiventris* Loew; (63) *R. minytus* Walk.; (g) Dexidae: (64) *Zelia* sp. (h) Anthomyidae: (65) *Hydrotaea bispinosa* Zett.; (66) *Limnophora* sp.; (67) *Phorbia* sp. D. Coleoptera—(a) Elateridae: (68) *Elater collaris* Say; (b) Lamperidae: (69) *Telephorus flavipes* Lec.; (70) *Pyractomena angulata* Say; (71) *Telephorus fraxini* Say; (72) *Pyropyga decipiens* Harr.; (c) Dermestidae: (73) *Anthrenus* sp.; (d) Cerambycidae: (74) *Leptura vagans* Oliv.; (75) *L. chrysocoma* Kb.; (76) *L. vittata* Germ.; (e) Melandryidae: (77) *Canifa*, sp.; (f) Mordellidae: (78) *Anaspis rufa* Say; (79) *Mordella marginata* Melsh. E. Hemiptera—two species. July 9–July 31.

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WALDOBORO, MAINE.